GIANT FISH BLENDERS:

HOW POWER PLANTS KILL FISH & DAMAGE OUR WATERWAYS

(AND WHAT CAN BE DONE TO STOP THEM)

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GIANT FISH BLENDERS: HOW POWER PLANT INTAKE STRUCTURES KILL FISH AND DAMAGE ECOSYSTEMS (AND WHAT CAN BE DONE TO STOP THEM)

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EXECUTIVE SUMMARY

From an airplane window, you might see power plants lining the banks of the Mississippi River, our coastal shores or the Great Lakes. It is no coincidence that power plants are located along some of our mightiest rivers and most treasured waterways: steam-electric power plants using older technologies need an extraordinary amount of water to operate. The power industry uses more water than any other sector in the United States, withdrawing more than 200 billion gallons of water each day. Nearly all this water is used for "once-through cooling," an antiquated technology were power plants suck enormous volumes of water to cool down their systems and then discharge it at an elevated temperature.

A power plant with once-through cooling draws hundreds of millions, in some cases billions, of gallons of water each day from the closest lake, river or ocean and indiscriminately sucks in whatever aquatic life is near the intake pipe. In this process, fish and other aquatic life are smashed and mutilated against crude screens (known as "impingement") or are sucked into the cooling system itself (known as "entrainment"). It is estimated that billions of fish and other aquatic organisms at all stages of life are killed each year by power plants' water-intake systems.

The full spectrum of aquatic species are impacted by once-through cooling, as are the other wildlife that rely on the complex food web—from phytoplankton to fish, birds, and marine mammals, including species that are threatened or endangered. Power plants' intake structures kill billions of fish and destabilize wildlife populations. A single power plant can obliterate billions of fish eggs and larvae and millions of adult fish in a single year, and the heated water it discharges also alters surrounding ecosystems, compounding the damage. The death toll of wildlife from power plant intakes is staggeringly high. Some areas face devastating economic impacts as fisheries are threatened and recreational uses are diminished.

This report looks at the impact of once-through cooling systems on some of the nation's most iconic waterways: the Great Lakes; the Gulf of Mexico; the Mississippi River; the Hudson River, New York Harbor and Long Island Sound; the California Coast; and the Chesapeake Bay. These great American waterways are at risk of losing untold species and ecosystems that have shaped the history, economy and culture of the surrounding areas.

We also look at the history of and actions taken by decision makers in regulating once-through cooling systems. Almost 40 years after Congress identified cooling water intake as a threat to our waterways and the life sustained by them, the U.S. Environmental Protection Agency (EPA) has failed to force the owners of power plants—the nation's largest water users—to reduce their destructive impact.

Today, the EPA is proposing regulations that, unfortunately, fail to set a clear, consistent national policy and fail to modernize our electric sector by phasing out once-through cooling systems. Even though the EPA has identified cost-effective alternatives, which are already being used in new power plants across the country, industry lobbyists are fighting hard to prevent any modernization of the outdated cooling systems at power plants, many built more than 30 years ago. This report highlights why the EPA must move quickly to strengthen proposed regulations and phase out the most destructive water-cooling practices by putting in place common-sense protections for fisheries and waterways across the United States.

PHOTO: PISCES CONSERVATION, LTD

PHOTO: PISCES CONSERVATION, LTD

LEFT: Just one outdated power plant can trap and kill millions of fish and other aquatic animals against crude water intake screens, like the ones shown here.

INTRODUCTION

POWER PLANTS USE WATER—and lots of it. In the United States, more than 500 power plants withdraw billions of gallons of water each day to use in the most antiquated and destructive type of cooling system, known as "once-through cooling." Once-through cooling systems draw water from a nearby waterbody and then discharge it at an elevated temperature, causing severe ecosystem destruction.

Collectively, steam-electric power plants have the capacity to withdraw more than 370 billion gallons per day—more than 135 trillion gallons per year—from our nation's waters for cooling.[1] Currently, those plants' average withdrawal exceeds 200 million gallons each day.[2] This accounts for 93 percent of the country's total saltwater use, 41 percent of total freshwater use, and 49 percent of all water use. That's more water than all irrigation and public water supplies combined.[3]

One-through cooling systems use large pipes as water-intake structures. These pipes sit below the water's surface and suck in not only water but also anything else in the vicinity. After the water is drawn through the power plant to help cool systems that have generated heat during the energy-making process, it is discharged at an elevated temperature back into the waterbody. This process affects the full spectrum of wildlife in the aquatic ecosystem at all life stages—eggs, larvae, juveniles and adults—from tiny photosynthetic organisms to fish, shrimp, crabs, birds and marine mammals, including threatened and endangered species.[4]

How Power Plant Intake Structures Harm Our Waterways

Power plants' intake structures kill billions of fish and destabilize wildlife populations. Since intake structures sit well below the surface of the water, fish and other aquatic life are hit the hardest. A single power plant can destroy billions of fish eggs and larvae and millions of adult fish in a single year, and its heated discharges alter the surrounding ecosystems, compounding the damage. In addition to fish, these outdated intake structures also kill or harm sea turtles, seals, sea lions and numerous other larger animals.[5]

This excessive mortality occurs despite rudimentary attempts to filter extraneous materials, including fish, from the cooling water stream. Fish eggs, larvae and other organisms are too small to be filtered out by even the best screens. The destruction is twofold: Larger fish and wildlife must fight against "impingement," or getting trapped on intake screens. And aquatic organisms too small to be trapped against these screens become "entrained," or sucked through plants' heat exchangers, where most are smashed and boiled to death before being dumped back into a waterbody.

The EPA has found that the loss of large numbers of aquatic wildlife may affect the overall health of ecosystems.[6] Once-through cooling not only reduces adult populations of the species, but also kills their eggs and larvae, causing disruptions to the food chain. These antiquated intake structures also reduce the species' ability to survive other unfavorable environmental conditions such as drought and climate change.[7]

The History of Once-through Cooling Destruction

In the late 1960s, Congress first considered the impacts of power plants' massive water usage during extensive hearings on the effects of waste heat discharged from industrial facilities.[8] Senator Warren Magnuson warned that "by 1980 thermal power plants throughout the nation will require an amount of cooling water greatly in excess of the average flow of the mighty Mississippi at St. Louis."[9] Around the same time, the White House issued a report explaining that "the large volumes of water withdrawn in once-through cooling processes [can have] as much or more effect on aquatic life than the waste discharges on which control measures are required."[10]

In the early 1970s, a number of well-publicized massive fish kills occurred at intake structures around the country. In response to the fish kills and other threats to our waterways, Congress voted overwhelmingly to pass the Clean Water Act of 1972 into law. While it focuses mostly on the discharge of pollution, the law also specifically regulates cooling water intake structures.

Section 316(b) of the Clean Water Act requires the EPA to issue regulations requiring that "the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact."[11] Those adverse environmental impacts are primarily the entrainment and impingement of fish, shellfish and other forms of aquatic life, along with thermal pollution in the discharge of cooling water.

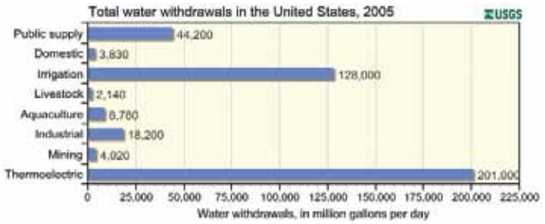
In 2001, after decades of delay, the EPA took an important step forward by ordering new plants to use "closed-cycle cooling" and prohibiting once-through cooling for new projects except in extremely limited circumstances.[12] In a closed-cycle cooling system, water withdrawn from a natural waterbody is circulated through condensers to remove the plant's excessive heat, then circulated through cooling towers, and then recirculated (i.e., recycled) back to the condensers. Compared with a once-through system—in which water is drawn into the condenser and then sent back to the waterbody from which it came—closed-cycle cooling can reduce total water withdrawals by about 95 percent. Because closed-cycle cooling is a better and newer technology, Clean Water Act permits issued by states and the EPA's regional offices for the construction of new power plants invariably require that it be installed.

However, the EPA has failed to follow through on its legal obligation to require existing power plants to modernize and phase out once-through cooling. Industry lobbyists have successfully stalled EPA action for a decade after it set new standards for new power plants. As a result, outdated power plants across the U.S. continue to kill billions of fish and other aquatic organisms annually on our nation's most iconic waterways.

About This Report

In the pages that follow, we provide specific examples of how antiquated cooling water intake structures are directly impacting some of our nation's most iconic waterways and their ecosystems: the Gulf of Mexico; the Mississippi River; the Hudson River, New York Harbor and Long Island Sound; the California Coast; the Great Lakes and the Chesapeake Bay. While we discuss only a handful of examples, there are many other waterways around the country being similarly harmed by antiquated power plants.

We must stop the giant fish blenders that line our shores, lakes and rivers. By phasing out once-through cooling, the EPA can help begin the process to restore and preserve our waterways for generations to come.



THE GREAT LAKES

PHOTO: LAKE ERIE WATERKEEPER

THE GREAT LAKES—Superior, Michigan, Huron, Erie and Ontario—and their connecting channels form the largest freshwater system on Earth. Covering more than 94,000 square miles, and draining twice as much land area, these freshwater bodies hold about 6 quadrillion gallons of water, about one-fifth of the world's fresh surface water supply and 90 percent of the U.S. freshwater supply. The Great Lakes provide drinking water to more than 40 million people.[13]

The Great Lakes region possesses a mosaic of connected ecosystems containing diverse communities of species, including about 180 native fish species such as brook trout, lake sturgeon, lake trout, lake herring, largemouth bass, northern pike, whitefish, smallmouth bass, walleye and yellow perch.

Each species within the Great Lakes has its place within the food chain and is dependent on the abundance and health of the whole ecosystem. At the base of the food chain are the primary producers, like algae, that collect energy from light. Feeding on these are the small zooplankton amphipods and other organisms that are, in turn, eaten by larger invertebrates such as shrimp. The next link includes fishes such as alewives, shiners and lake herring, which provide sustenance to the predatory fish, like lake trout and bass. All these fish then provide food for birds, reptiles, amphibians and mammals that live by the Great Lakes, including humans.

The Great Lakes are linked to coastal wetland and bordering terrestrial ecosystems that support many threatened and endangered animals, including the whooping crane, Canadian lynx, gray wolf, bog turtle, as well as plants such as the dwarf lake iris. They also provide essential habitat to a symbol of our country, the once-endangered bald eagle.

Because of the importance of these lakes, many underwater preserves and parks have been established throughout the area, and outdoor recreation is a major part of life in the region. With pristine wilderness in close proximity to major cities in eight states—Illinois, Indiana, Michigan, Minnesota, New York, Ohio, Pennsylvania and Wisconsin—as well as the Canadian province of Ontario, the Great Lakes region provides abundant opportunities for fishing, boating, swimming, bird-watching and tourism.

The Great Lakes states have about 3.7 million registered recreational boats, about a third of the nation's total,[14] and the commercial and sport fishing industry is collectively valued at more than $7 billion annually.[15]

A 2007 report by the Brookings Institution determined that a healthy, restored Great Lakes could generate some $50 billion in long-term economic benefits for the region, not only for industries like fishing, which rely on clean, healthy ecosystems, but also for the tourist industry and for homeowners, in the form of higher property values.[16]

Most lake ecosystems are dependent on their shores and shallows for their productivity, and the Great Lakes are no different. However, the Great Lakes are unique because of their size: Only a small proportion of their volume is within these productive shallow zones. The Great Lakes are therefore particularly vulnerable to any damage to their shallows, where shoreline power plant intake structures are located.

How Power Plant Intake Structures Harm the Great Lakes

At least 42 power plants using once-through cooling systems ring the Great Lakes. Lake Michigan has the largest number of these plants, with 19, followed by Lake Erie's 11, Lake Huron's six, Lake Ontario's five, and Lake Superior's one. Thirty-three of the plants run on coal, six are nuclear, and the rest burn natural gas or oil. These plants withdraw massive volumes of water, ranging from the relatively small Harbor Beach plant on Lake Huron, which can withdraw 129 million gallons per day, to the behemoth D.C. Cook plant on Lake Michigan and the Monroe plant on Lake Erie, both of which can withdraw more than 2 billion gallons.[17] The 42 Great Lakes plants have a combined intake flow of more than 30 billion gallons per day. (See Appendix, Table 1, for a full list of Great Lakes plants and their intake flow rates.)

These plants' intake structures kill huge numbers of fish and shellfish of virtually every species present and at every life stage. All links in the Great Lakes food chain are adversely affected by these power plants. For example, when operating at full capacity, the Bayshore plant in Ohio sucks up more than 700 million gallons of water per day from the middle of Maumee Bay, in western Lake Erie, the most productive fishery in the Great Lakes.

LEFT: Scenic Lake Erie has 12 antiquated power plants on its shores that use almost 10 billion gallons of water everyday.

ABOVE: Bayshore power plant in Ohio has been known to kill 60 million fish in just one year because of outdated water intake structures.

A 2005–6 study conducted by Bayshore's owner estimated that more than 60 million adult fish and more than 2.5 billion fish eggs and larvae were killed per year.[18] A later study of the Bayshore plant by the University of Toledo put the number of fish eggs and larvae killed at more than 12 billion per year. The plant's once-through cooling system also dumps hot water into western Lake Erie, contributing to foul-smelling, toxic algal blooms and causing further harm to fish populations in a vital but already heavily stressed ecosystem.

On the shores of Lake Michigan in Wisconsin, the Oak Creek power plant was estimated by its operator to impinge well over 2 million fish weighing 57-plus tons in a single year on its intake screens. In addition, between April and October of 2002, it entrained over 6 million larvae and over 9 million fish eggs.[19]

New York's Huntley Generating station, located along the Niagara River, which connects Lake Ontario to Lake Erie near the world-famous Niagara Falls, is estimated to entrain over 105 million fish eggs and larvae per year, with annual impingement of well over 96 million adult and juvenile fish—the largest of any power plant in the state.[20]

A clear illustration of the ecological benefits that could be obtained by installing closed-cycle cooling at the 42 Great Lakes plants is evident from the experience of the Palisades nuclear power plant on Lake Michigan, which was built with once-through cooling and later installed closed-cycle cooling. When operating in once-through mode, the plant impinged almost half a million fish per year, but this figure was reduced by an astounding 98 percent once the plant switched to closed-cycle cooling.[21]

Ecosystems in the Great Lakes face many other stresses, including pollution and destructive invasive species. This makes mortality from once-though intake structures more potentially detrimental to native species than it would be in healthy ecosystems. Since so many fish and other aquatic creatures are killed, their populations become smaller, weaker, and more vulnerable to collapse.

The Great Lakes are an important resource for the nation. The region's unique environment includes wetlands, marshes, swamps and bogs that play a critical role in linking land with water. These lakes enrich the lives of communities around them and define the region. They are a haven for hunters, anglers and all outdoor enthusiasts, and also an economic driver of the nation. Updating the 42 power plants on the shores of the Great Lakes would help ensure that they remain clean and healthy for future generations.

ABOVE: Endangered whooping cranes, like these, are dependent on healthy fish populations in the Great Lakes.

CENTER: On Lake Michigan in Wisconsin, the Oak Creek power plant was estimated by its operator to impinge well over 2 million fish weighing 57-plus tons in a single year.

BELOW: The Great Lakes communities have about 3.7 million registered recreational boats, about a third of the nation's total.

FAR RIGHT: A healthy Great Lakes, such as Lake Heron pictured here, could yield $50 billion in long-term economic benefit for the region.

GULF OF MEXICO

PHOTO: PISCES CONSERVATION, LTD

THE GULF OF MEXICO is the ninth-largest body of water in the world, covering 600,000 square miles, and it receives water from 33 major rivers, including the Mississippi and Rio Grande.[22] More than half of the coastal wetlands within the continental United States are in the Gulf of Mexico, including 15,316 square miles of estuarine habitat along the shoreline in the Gulf Coast states of Alabama, Florida, Louisiana, Mississippi and Texas. This important coastal habitat is essential for healthy fisheries, migrating waterfowl, seabirds and wading birds. Wetlands also play an irreplaceable role in protecting shoreline communities from increasingly dangerous storms.

The Gulf's estuaries, with their associated mangrove and seagrass habitats, are essential feeding and nursery grounds for large numbers of fish and other wildlife, including threatened and endangered species such as sea turtles, Gulf sturgeon and manatees. Mangroves defend coastlines from flooding and erosion and provide essential habitat for reptiles such as the American crocodile and American alligator; sea turtles such as the loggerhead; fish such as snapper and tarpon; crustaceans such as shrimp and crabs; and coastal and migratory birds, including pelicans, spoonbills and bald eagles. Seagrass beds are also fish nurseries, where manatees and sea turtles feed and thrive. Additionally, the Gulf of Mexico yields more shrimp and shellfish annually than the mid-Atlantic, Chesapeake and New England areas combined.[23]

Of the 28 species of marine mammals known to inhabit the Gulf of Mexico, three are protected species of dolphin (Atlantic spotted, Risso's and bottlenose).[24] A number of endangered fish live in the coastal and estuarine waters, including the Gulf sturgeon, Alabama shad, saltmarsh topminnow and mangrove rivulus. The Gulf's threatened and endangered sea turtles include the loggerhead and leatherback, which thrive in the Gulf's expansive and unique waterways.

Besides being home to all types of wildlife, the Gulf supports major fishing industries.[25] Gulf fisheries are among the most productive in the world, with commercial fish and shellfish valued at $661 million annually.[26] In 2008, recreational fishers took more than 24 million trips, catching 190 million fish, in the Gulf of Mexico and surrounding waters.[27] The Gulf of Mexico's shores and beaches, an ideal location for swimming, sun and all water sports, support a $20 billion tourism industry.[28]

How Power Plant Intake Structures Harm the Gulf of Mexico

The Gulf coastal region has at least 17 power plants that use once-through cooling systems: seven in Florida, seven in Texas, two in Louisiana, and one in Mississippi. Four of the plants—the Big Bend, Crystal River and Lansing Smith plants in Florida, and the Jack Watson plant in Mississippi—burn coal; the Crystal River plant site also has a nuclear reactor. The rest of the plants along the Gulf burn natural gas or oil.

These plants withdraw billions of gallons of water each day from the Gulf of Mexico and its coastal bays, entraining and impinging huge numbers of fish and shellfish of virtually every species present—at every life stage—and discharging heated water back into the Gulf. The largest-flow plants are the Anclote plant, north of St. Petersburg, Florida, at more than 2.8 billion gallons per day; the Crystal River plant complex, just 50 miles up the west coast of Florida from Anclote, at more than 2.1 billion gallons per day; and the P. H. Robinson power plant in Galveston Bay, Texas, which is designed to take in more than 1.7 billion gallons per day. Combined, the 17 Gulf plants can withdraw nearly 13 billion gallons of water per day, and there are many other power plants withdrawing even larger volumes of freshwater from the rivers that feed the Gulf, killing aquatic life and discharging heated water back into the ecosystem as well. (See Appendix, Table 2, for a full list of Gulf plants and their intake flow rates.)

In the Gulf especially, thermal pollution can directly impact plants and animals, degrading habitat and reducing biodiversity. Both mangrove and seagrass beds are sensitive to power plants' thermal pollution. For example, the Thalassia seagrass beds in Florida estuaries are drastically affected when contacted by discharges 41 degrees Fahrenheit or more above the ambient summer temperature. These overly warm discharges on the seagrass beds can result in total destruction of this plant life and in turn damage the populations of wildlife that depend on it.[29]

A number of protected fish and sea turtle species live in waters impacted by power plants and are impinged or trapped on intake screens. For example, the Crystal River plant has impinged five species of endangered sea turtles—loggerhead, green, Kemp's ridley, leatherback and hawksbill.[30] At the Big Bend generating station in Tampa Bay, Florida, the annual impingement from 1976 to 1977 was estimated to be more than a quarter of a million fish.[31]

Entrainment of young species is a major problem in productive coastal and estuarine waters. At the Big Bend plant, the annual entrainment of a single species, the bay anchovy, was estimated at more than 68 billion from 1976 to 1977.[32] The Big Bend power plants still uses that same once-through cooling system today, 30-plus years later.

The Gulf of Mexico is one of the most biodiverse bodies of water on the planet and one of the most economically productive regions in the world.[33] It is home to a range of sea life including dolphins, oysters and coral reefs. Its coastline encompasses wetlands and includes tidal flats, mangrove swamps, estuaries and bays. Power plants along the Gulf should be required to update their cooling system technologies to protect aquatic life, coastal communities, tourism and commercial fishing in the region.

CLOCKWISE FROM UPPER LEFT: The Gulf of Mexico yields more shrimp and shellfish annually than the mid-Atlantic, Chesapeake and New England areas combined. However, outdated water intake structures can trap and kill them, as shown here. Not only fish are killed by power plants. Turtles, like the endangered loggerhead shown here can become trapped on crude intake screens. The Gulf is not only known for its wildlife, but also as a destination for many outdoor enthusiasts such as beach combers and boaters.

MISSISSIPPI RIVER

ONE OF THE MOST FAMOUS RIVERS in the world, the Mississippi is the largest river system in North America, draining almost one-third of the total U.S. land mass. At approximately 2,350 miles long, the Mississippi is the third-longest river in North America,[34] is the fifth largest river in the world by volume and has the third largest drainage basin in the world,[35] covering more than a million square miles.[36] The river basin drains all or parts of 31 states and two Canadian provinces, and flows through ten states: Arkansas, Illinois, Iowa, Kentucky, Louisiana, Minnesota, Mississippi, Missouri, Tennessee, and Wisconsin.

By virtue of its great size and other geographic factors, the Mississippi river system is one of North America's most important environmental resources, containing a variety of habitats and an extraordinarily great aquatic biodiversity. The river basin supports at least 375 species of native fish, which are rather evenly distributed across the region.[37]

The Mississippi is noted for its numerous large river fish, which include the shovelnose sturgeon, gar, and bowfin. Other native fish of the Mississippi are the shad, chub, perch and bass.[38] Migratory birds visiting the river include Canadian geese, swans, bluebirds, and pelicans, many types of songbirds, and mallard, widgeon, pintail and ring - necked ducks.

The upper river valley contains large wetland areas, magnificent hardwood forests and some of the richest soils and most pristine habitats for wildlife found in the United States. Species living within the upper river valley's catchments include white-tailed deer, wild turkeys, mink, muskrats and otters—all of which depend on a healthy Mississippi River.

The Lower Mississippi, below the Ohio River confluence, lies within the lowland gulf coastal plain, a basin between the Appalachians to the east and the Ozark and Ouachita Mountains to the west. The Lower Mississippi is distinguished by its extraordinary richness of species, particularly fish, shellfish and crayfish. It is also home to nearly 70 species of amphibians and aquatic reptiles, including the American alligator and two common turtles—the ringed map turtle and yellow-blotched map turtle. Among the numerous marine species commonly recorded in the Mississippi's lower reaches, where it meets the saltwater environment of the Gulf of Mexico, are minnows, catfish, killifish and darters.

Because of its rich diversity and beautiful scenery, the Mississippi River has seven National Park sites along its banks; in 1997, two portions of the Mississippi were designated as American Heritage Rivers. In 2009, the Upper Mississippi River floodplains, which include the 240,000-acre Upper Mississippi River National Wildlife and Fish Refuge, were designated as a Wetland of International Importance.

In addition to its ecological and social values, the Mississippi has significant economic value as the nation's chief navigable water route for commerce. It provides many states with drinking water and has spurred the growth of the its neighboring cities and economies. The Mississippi provides abundant hunting, fishing, canoeing, camping and other recreational opportunities for millions of Americans. Its riverside parks and trails are popular spots for hiking, biking, fishing and bird-watching. A healthy Mississippi River is vital to the quality of life in its nearby communities.

How Power Plant Intake Structures Harm the Mississippi River

At least 28 power plants still using once-through cooling systems are located on the Mississippi River. Louisiana is home to six of these plants; Iowa has five; Minnesota, Missouri and Wisconsin each have four; Illinois has two; and Arkansas, Mississippi and Tennessee each have one. Seventeen of these plants burn coal; seven burn natural gas or oil; three are nuclear; and one, the Waterford plant in Louisiana, has a nuclear unit as well as oil or gas units. These 28 plants have a combined cooling water withdrawal capacity of more than 15 billion gallons per day, and their massive water withdrawals entrain and impinge enormous numbers of fish and shellfish of virtually every species and at every life stage. (See Appendix, Table 3, for a full list of Mississippi River plants and their intake flow rates.)

Mississippi power plants using once-through cooling range from the relatively small Burlington plant in Iowa, which can withdraw 116 million gallons per day, to the behemoth Nine Mile Point plant in Illinois and the Quad Cities plant in Louisiana, which each withdraw well more than a billion gallons per day.[39]

As just one example of the impact of these power plants on fish, consider the coal-fired Meramec power plant, located 16 miles south of St. Louis, Missouri, at the confluence of the Mississippi with the Meramec Rivers. Impingement and entrainment studies conducted there in the 1970s, when the plant's maximum flow was about 550 million gallons per day, an estimated annual impingement of almost a million fish, including the vulnerable shovel-nosed sturgeon.

Meramec's entrainment of fish eggs was greatest in July, when an average of 70.7 fish eggs was entrained per 100,000 gallons. Given that the plant utilized more than 9.5 billion gallons of cooling water in July 1974 during the study period, the estimated entrainment for that one month alone was well over a half a million eggs.[40] Since Merrimac's intake capacity has increased to 675 million gallons per day, with no change to its outdated intake structures, the impingement and entrainment impacts are likely even worse today.

The Mississippi River, from the small headwaters in the Northwoods of Minnesota to the large ecosystem of the Gulf of Mexico, is a true national treasure that has played a large role in shaping American culture and history. Power plants along the Mighty Mississippi should use the best and most modern technology to protect the wildlife and the economy the river provides.

CLOCKWISE FROM UPPER LEFT: Meramec power plant, located 16 miles south of St. Louis, Missouri, at the confluence of the Mississippi with the Meramec Rivers, impinges and entrains almost a million fish per day. The Mississippi River needs healthy fish populations for the next generation of anglers. The 28 power plants on the mighty Mississippi have a combined cooling water withdrawal capacity of more than 15 billion gallons of water per day. A healthy Mississippi River is vital to the quality of life in its nearby communities and wildlife.

HUDSON RIVER, LONG ISLAND SOUND AND NEW YORK HARBOR

INDIAN POINT PHOTO: RIVERKEEPER, INC.

Hudson River

Known as "America's First River," the Hudson begins at Lake Tear of the Clouds in the Adirondack Mountains and flows more than three hundred miles before emptying into New York Harbor at the southern tip of Manhattan. Called *Muhheakantuck* ("the river that flows both ways") by Native Americans and now named for the British explorer Henry Hudson, the historic Hudson River played a starring role in the American Revolution and provided a crucial transportation link from the eastern seaboard through the Erie Canal to the country's interior.

The lower Hudson's unique configuration as a narrow, 154-mile-long estuary creates a huge, diverse nursery that supports a mix of freshwater and saltwater fish. The river's marshes and tidal flats contribute essential minerals and nutrients to the food chain, allowing its quiet backwaters to become an essential nursery habitat for many types of wildlife. In fact, the Hudson is one of the two principal spawning grounds for aquatic life in the East Coast.

More than two hundred species of fish are found in the Hudson and its tributaries, which make up one of the most biodiverse temperate estuaries on the planet. The river is a refuge for rare and endangered species such as the shortnose sturgeon and heartleaf plantain.[41] The Hudson is also part of the great Atlantic flyway for migratory birds; and ducks, geese and osprey, among others, stop to feed in its shallows.

The ecological influence of the Hudson estuary extends far into the Atlantic Ocean and along the coast. For vast schools of migratory sturgeon, herring, blue crab, mackerel and striped bass, the Hudson is a nearly unimpeded corridor from the Atlantic to their ancestral spawning grounds. These fish support a 350-year-old recreational and commercial fishery along the Atlantic coast that's worth hundreds of millions of dollars.[42]

In 1998, the Hudson River was designated as one of the nation's first American Heritage Rivers, a much-deserved recognition of its central place in American history and culture. The New York State Legislature has declared the estuary "of statewide and national importance as a habitat for marine, anadromous, catadromous, riverine and freshwater fish species,"[43] and two federal agencies—the U.S. National Oceanographic and Atmospheric Administration and the U.S Fish and Wildlife Service—have designated the Hudson as an Essential Fish Habitat because it sustains large numbers of commercially important fish species.[44]

CLOCKWISE FROM LEFT: Long Island Sound, pictured here has eight outdated power plants that use over 5 billion gallons of water per day. At the Indian Point power plant, situated in a narrow section of the Hudson River estuary and pictured here, has entrained 1.2 to 1.3 billion fish eggs and larvae in a year. Ospreys, like these in Long Island, depend on healthy fish populations for survival. The Long Island Sound isn't only a sanctuary for wildlife, like the starfish pictured here, but also for people and communities who enjoy the outdoors. The Hudson River, pictured here has four outdated power plants on its shores that use well over 4 billion gallons of water per day.

PHOTO: GILES ASHFORD

Long Island Sound

The Long Island Sound is a 110-mile-long estuary bordered by the Connecticut coastline and the north shore of Long Island, New York. It receives the flow of several major rivers that drain freshwater from Massachusetts, New Hampshire, Vermont and other states. The Sound is a unique estuary in that it has two connections to the sea: to the east, it opens to the Atlantic Ocean, and to the west, it connects to New York Harbor and the Hudson and East Rivers. The Sound provides feeding, breeding, nesting and nursery areas for a broad diversity of plant and animal life, including marine fish and shellfish species such as winter flounder, Atlantic menhaden, blue crab, shrimp and lobster.

The extensive tidal marshes bordering the sound are some of the most productive biological systems in the world. They produce between three and seven tons per acre per year of vegetation; much of this eventually enters the waters of the sound to support fish and shellfish habitat.

More than eight million people live in the Long Island Sound watershed, which contributes an estimated $8 billion per year to the regional economy through boating, commercial fishing and sportfishing, swimming and tourism.[45] Long Island Sound was designated as an Estuary of National Significance, and some of its harbors have been designated as a Significant Coastal Fish and Wildlife Habitat Area or Essential Fish Habitat under the Magnuson-Stevens Fishery Conservation and Management Act.

LEFT: **New York Harbor, pictured here, has five antiquated power plants on its shores that use well over 3 billion gallons of water per day.**

RIGHT: **Outdated coal power plants on our rivers, like Danskammer on the Hudson River, suck in almost half a billion gallons of water per day.**

New York Harbor

In the shadow of Manhattan's skyscrapers, New York Harbor and the East River connect the metropolitan area's two major estuary systems, the Hudson and Long Island Sound. The National Marine Fisheries Service has noted that four species of sea turtles may inhabit the vicinity of New York: Kemp's Ridley, green, leatherback and loggerhead; the first three are listed as endangered.

How Power Plant Intake Structures Harm the Hudson River, Long Island Sound and New York Harbor

A total of 17 power plants using once-through cooling are located in the region: four on the Hudson River, eight on the Long Island Sound and five in New York Harbor. New York has 12 of these plants, and Connecticut five. Two of these plants are nuclear, and the rest burn natural gas or oil, with the exceptions of the Bridgeport Harbor plant in Connecticut and Danskammer plant in New York, both of which have coal-fired units. All these plants use exorbitant amounts of water. The two nuclear plants, the Indian Point plant on the Hudson and the Millstone plant on the Sound, can withdraw 2.5 billion and 2.19 billion gallons per day, respectively.

The Hudson River plants have a combined intake capacity of nearly 5 billion gallons per day; the Long Island Sound plants have a combined intake capacity exceeding 5 billion gallons per day; and the New York Harbor and East River plants have a combined intake capacity of more than 3.5 billion gallons per day. Altogether, the 17 plants can withdraw almost 14 billion gallons per day from the two estuaries and the harbor. (See Appendix, Table 4, for a full list of the Hudson River, Long Island Sound and New York Harbor plants and their intake flow rates.)

Because of these waters' importance as spawning and nursery grounds, it is unsurprising that entrainment of eggs and larvae occur in astronomic numbers.

According to Soundkeeper's calculations, based on available data, the Millstone plant is responsible for killing 154 billion fish in all life stages over the span of more than three decades.[46] These calculations are very conservative, considering that the data only include seven species found in the Sound—winter flounder, cunner, bay anchovies, tautog, menhaden, grubby and American sand lance—and do not include lobsters, crabs, shellfish and other area fish.[47] In particular, Millstone killed nearly 42 billion tautog eggs and larvae between 1979 and 2002 and well over 4 billion winter flounder between 1976 and 2003.[48]

Huge numbers of fish are also entrained at the Indian Point power plant, situated in a narrow section of the Hudson River estuary just south of Peekskill. As reported by the New York State Department of Environmental Conservation, 1.2 to 1.3 billion fish eggs and larvae are entrained at Indian Point each year.[49] Further, an average of 1.18 million fish per year was impinged by Indian Point from 1986 to 1990.[50] The Indian Point plant impinges the endangered shortnose sturgeon and the Atlantic sturgeon, a candidate for threatened species status, thereby negatively contributing to the already low populations of these fish.[51] These devastating impacts were understood decades ago: In the 1970s, the Atomic Energy Commission, and its successor, the Nuclear Regulatory Commission, directed the owners of Indian Point to install closed-cycle cooling because of the anticipated damage to the Hudson's fisheries and ecosystem.[52]

Indian Point and the other three power plants using once-through cooling on the Hudson have a huge, detrimental impact on the ecology of the estuary—and this impact goes well beyond the loss of large numbers of individual fish. In a 2007 report, New York State found that the cumulative impact of multiple facilities on the river substantially reduces the population of young fish in the entire river. In certain years those plants have entrained between 33 and 79 percent of the eggs and larvae spawned by striped bass, American shad, Atlantic tomcod and five other important species.[53] Over the time the plants have been operating, the ecology of the Hudson River has been altered, with many fish species in decline and populations becoming less stable. Of the 13 key species subject to intensive study, ten have declined in abundance, some greatly.[54] Power plants have played a considerable role in that decline.

The power plants that rely on outdated once-through cooling to generate electricity affect the full spectrum of wildlife in the aquatic ecosystem at all life stages. New York's iconic Hudson River, New York Harbor and Long Island Sound are not only home to countless wildlife species but are also vital waterways for the cities and communities around them.

CALIFORNIA COAST

THE SPECTACULAR 840-MILE Pacific Coast of California, legendary to surfers and beachcombers around the world, offers an incredible variety of shoreline habitats—exposed rocky shores, kelp forests, sandy beaches, sheltered muddy estuaries and hypersaline lagoons. The Pacific Ocean supports a rich diversity of species and habitats, including populations of seabirds and shorebirds; marine mammals like humpback whales, elephant seals and sea lions; and fish such as barracuda, mackerel, salmon, albacore, bluefin and yellowfin tuna, and sardine and rainbow trout, to name just a few. A number of threatened and endangered fish species live in California's coastal waters.

The northern portion, stretching from the Oregon border to San Francisco, is a landscape of rugged coastlines and towering majestic redwoods at or near the water's edge, with incredible vistas and opportunities for hiking, kayaking, river rafting, mountain biking, wildlife-watching, rock climbing, fishing and camping. Tidelands and marshes in this area provide important habitat for many species of waterfowl, shorebirds and marine invertebrates, as well as nursery areas for fish and crustaceans. The Point Reyes peninsula alone supports 45 percent of North American bird species and almost 15 percent of Californian plant species, including 23 threatened and endangered species.[55]

The San Francisco Bay and Delta is one of the largest estuarine systems on the West Coast and a highly dynamic and complex environment. The delta is a maze of river channels and diked islands covering over 1,000 square miles, including 78 square miles of water, formed by the confluence of the Sacramento and San Joaquin Rivers, which ultimately drain into San Francisco Bay.[56]

San Francisco Bay is made up of deepwater channels, tidelands, marshlands, freshwater streams and rivers that provide a wide variety of habitats that sustain a highly biologically diverse ecosystem. More than half of the endangered species in San Francisco Bay depend on wetlands to survive, including the California clapper rail and salt marsh harvest mouse. Local fish species on the federal endangered and threatened species list include the winter-run chinook salmon and the Sacramento splittail. Nearly all of the San Francisco Bay region beaches form part of the Golden Gate National Recreation Area, one of the most visited National Parks, with more than 13 million visitors each year.[57]

The central and southern coasts extend from the Monterey Peninsula to the Mexican border. Here one finds wildlife refuges, state parks and pristine beaches popular for surfing, hiking and camping. There are graceful, towering sand dunes that protect bays, coastal lagoons, harbors and coves popular for kayaking and fishing.

The angle of the Southern California coastline creates a huge backwater eddy in which equatorial waters flow north near the shore, and subarctic waters flow south offshore. The mixing of these waters creates a highly diverse system that supports about 500 fish and more than 5,000 invertebrate species.[58] This scenic and diverse region contains numerous wilderness areas, nature reserves, wildlife preserves and open-space areas.

California's commercial fishing operations rank higher than any other state in the nation. Tuna is the most valuable fish caught, followed by swordfish. Halibut, herring, mackerel, rockfish, sablefish, salmon and sole are also important to the fishery, as are crabs, shrimp and squid.[59]

As a mark of this waterway's importance, the California Coastal National Monument, encompassing the entire coastline, was created by presidential proclamation in 2000 to ensure the protection of all islets, reefs and rock outcroppings from the coast to a distance of 12 nautical miles.

SAN ONOFRE PHOTO: © 2010 DARRELL CLARKE, COURTESY SIERRA CLUB LIBRARY

How Power Plant Intake Structures Harm the California Coast

There are 17 coastal Californian power plants using once-through cooling systems. These plants can withdraw more than 14 billion gallons per day from the Pacific Ocean. Nearly 5 billion gallons of that flow is withdrawn by two nuclear plants: the San Onofre Nuclear Generating Station near San Clemente and the Diablo Canyon plant near San Luis Obispo. (See Appendix, Table 5, for a full list of California plants and their intake flow rates.)

These power plants kill an astounding number of fish. The annual entrainment of larval fish at the Diablo Canyon plant at average flow is estimated to be over 1.5 billion individuals.[60] At the San Onofre Nuclear Generating Station on the Southern California coast, 121 tons of midwater fish are entrained, causing a 34 to 70 percent decline in Pacific Ocean fish populations within about two miles (three kilometers).[61] Unit 3 of the San Onofre plant alone is estimated to entrain an average of over 3.1 billion individual aquatic organisms.

The Pittsburg and Contra Costa plants in the San Francisco Bay Delta impinge and entrain more than 300,000 endangered and threatened fish per year, including the Sacramento splittail, Chinook salmon and steelhead trout. The Contra Costa and Pittsburg power plants entrain and impinge threatened Delta smelt and endangered Longfin smelt.[62]

In addition to the entrainment of young life stages, Californian coastal plants impinge and kill huge numbers of older fish on their filter screens. At average flow rates, San Onofre's Units 2 and 3 combined were estimated to impinge 1.3 million fish with a total weight of over 14 tons.[63] This is the worst example on the California coast, but other plants also impinge significantly large numbers of fish. Units 6 and 7 at the Moss Landing plant were estimated to annually impinge a quarter of a million fish weighing 4,060 pounds, even though the plant's average intake flow is a relatively modest 387 million gallons per day.[64]

In May 2010, California adopted a strong state policy requiring most coastal power plants to upgrade over the next decade to achieve protections equivalent to those offered by closed-cycle cooling. However, the dirty energy industry continues to fight these requirements.

When contemplating the beauty of the Golden State, admirers invariably point to the breathtaking shoreline that has shaped California both culturally and historically. Power plants must help protect the beauty and economic vitality of the California Coast by using modern cooing system technologies.

CLOCKWISE FROM LEFT: On the California coast, there 17 antiquated power plants that suck in over 15 billion gallons of water every day. While smaller aquatic life is killed by outdated power plants, the affects move up the food chain to larger animals like whales that pass the California coast. California's shores are known not only for its amazing wildlife, but also its outdoor activities like scuba diving and surfing. Healthy tuna shoals, like the one shown here, are vital to economy of California.

CHESAPEAKE BAY

STRETCHING 200 MILES across Maryland and Virginia—and with a watershed also encompassing Pennsylvania, Delaware, West Virginia, New York and the District of Columbia—Chesapeake Bay is the largest estuary in the United States and the third-largest in the world. The Chesapeake was formed about 12,000 years ago, as glaciers melted and flooded the Susquehanna River valley. The Chesapeake Bay watershed is 64,000 square miles and includes more than 10,000 miles of tidal shoreline, including tidal wetlands and islands.

The Chesapeake Bay is fed by five major rivers: the Susquehanna, Potomac, Rappahannock, York and James. The Chesapeake holds more than 15 trillion gallons of water and, although its length and width are dramatically expansive, its average depth is only about 21 feet, making it sensitive to temperature changes and discharges.[65] Approximately 17 million people live in the watershed, 10 million of them along its shores or near them.[66]

Together with the rivers, creeks and streams that feed it, the Chesapeake Bay provides a vital habitat for many aquatic species. Within the sheltered waters of the Chesapeake, underwater seagrass beds support the base of the food chain. These beds offer food and protection for a large number of small animals and a nursery for young fish. More than 300 species of fish, 170 species of shellfish and 2,700 species of plants are found in the Chesapeake.[67]

The Chesapeake's fish species include striped bass, trout, flounder, bluefish, Spanish mackerel, channel bass, yellow and white perch, herring and American shad. The Chesapeake is a key component in the Atlantic flyway: More than a million ducks, geese and swans spend winters here each year and it provides stopover habitat to thousands of other migrating birds.[68] This delicate, complex ecosystem is home to a number of plant and animal species that are currently designated as threatened or endangered, including the peregrine falcon, loggerhead and Atlantic Ridley turtles and the shortnose sturgeon. The once-endangered bald eagle lives in the region, too, appropriately in close proximity to our nation's capital.

Along with being a vital ecosystem with a rich diversity of species, the Chesapeake offers wonderfully scenic places to visit. The shallow, protected waters of the Chesapeake Bay and its tributaries are ideal for canoeing and kayaking. The region offers opportunities for water recreation sports, including fishing, boating and swimming, as well as excellent trails along the water for bird-watching, hiking and mountain biking.

One of the Chesapeake's most significant contributions to the region's economy is its seafood industry. The Chesapeake is especially renowned for its blue crabs, clams, oysters and striped bass. More than 500 million pounds of seafood are harvested from the Chesapeake every year.[69] A 2008 U.S. National Oceanic and Atmospheric Administration report indicated that the commercial seafood industry in Maryland and Virginia contributed $3 billion and more than 41,000 jobs to the local economy.[70]

How Power Plant Intake Structures Harm Chesapeake Bay

At least seven power plants in Maryland and six in Virginia use once-through cooling systems on the shoreline of the Chesapeake Bay or on saline or brackish waters in immediate proximity to the bay. Of these 13 plants, two are nuclear (Calvert Cliffs in Maryland and Surry in Virginia), four are coal-fired (the Chesapeake, Chesterfield and Potomac River plants in Virginia and the Morgantown plant in Maryland), and seven burn natural gas or oil. The Calvert Cliffs nuclear plant is the largest cooling water user in the Chesapeake, with a design intake flow rate of more than 2.2 billion gallons per day. It is followed by Virginia's Surry and Yorktown plants and Maryland's Morgantown and Herbert A. Wagner plants, each of which can withdraw between 1 and 1.5 billion gallons of water per day. Together, these 13 power plants can withdraw more than 8 billion gallons of water per day. (See Appendix, Table 6, for a full list of Chesapeake plants and their intake flow rates.)

The removal of large volumes of water from a habitat as rich in wildlife as the Chesapeake Bay inevitably leads to environmental degradation. For example, Calvert Cliffs plant in Maryland was estimated to impinge an average of 1.3 million fish a year between 1975 and 1995 with a total weight of about 10 tons.[71] The plant also impinges an average of 627,000 blue crab per year.[72] In certain environmental conditions, Calvert Cliffs has caused fish impingement incidents of staggering proportion: On August 28, 1984, the plant impinged 146,000 spot fish in just one hour, and on August 2, 1984, 12,650 blue crab were collected from its Unit 1 screens in one hour.[73] Such massive fish kills have also caused operational problems like blockages and damage to the screens.[74]

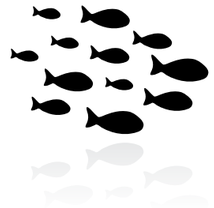
Entrainment losses of Chesapeake populations are also considerable. The Chalk Point power plant on the Patuxent River estuary in Prince George's County, Maryland, has two units that use once-through cooling, which together extract 500,000 gallons per minute from the estuary.[75] The Power Plant Research Program of the Maryland Department of Natural Resources estimated that Chalk Point's entrainment of bay anchovies could be as high as 76 percent of the local stock.[76]

The Chesapeake Bay and its tributaries are broadly recognized as a national treasure and vital resource. The Chesapeake creates opportunities for recreational and commercial fishing; is a beautiful place to swim, hike and boat; and is a world-class ecosystem for an untold number of species. The power plants along the Bay must upgrade their outdated systems to protect this iconic waterbody.

Famous for its blue crabs, the fishing communities around the Chesapeake Bay are dependent on healthy populations for their livelihoods. The Chesapeake creates opportunities for recreational and commercial fishing; is a beautiful place to swim, hike and boat. Once endangered bald eagles living in the Bay, like the ones shown here, are reliant on strong healthy fish populations. The 13 antiquated power plants on the Bay can withdraw more than 8 billion gallons of water per day.

PHOTO: PISCES CONSERVATION, LTD

CONCLUSION



The six examples in this report illustrate the real and immediate impacts of cooling water intake structures. The massacre caused by this antiquated technology is clear: The full spectrum of aquatic species and wildlife that rely on complex food chains in our lakes and rivers and on our shores—from phytoplankton to fish, birds, and marine mammals, and including species that are already threatened or endangered—is impacted by once-through cooling. Some areas face devastating economic impacts as fisheries are threatened and recreational uses are diminished.

The Environmental Protection Agency is charged with implementing Section 316(b) of the Clean Water Act, which requires the use of the best available technologies to minimize the environmental impact of power plants' cooling water withdrawals.

The modern closed-cycle cooling technology reduces the impacts of cooling water systems, is cost-effective, and is in use at many power plants across the country. It reduces water intakes by approximately 95 percent, drastically reducing the amount of water needed for power plant operations, thus resulting in a corresponding reduction in their impact on fish and other species.

Unfortunately, the EPA, under intense pressure from powerful industry interests, has ducked its responsibilities by not requiring existing power plants to upgrade to closed-cycle cooling or similar systems. Instead, in March 2011, the EPA proposed a rule that largely maintains the status quo, mandating little to no improvement in the technologies necessary to protect our waterways and our wildlife. The EPA's proposed rule sets a goal for impingement reductions that is already being achieved by 75 percent of U.S. power plants, thus requiring only marginal improvement in fish impingement across the country, and fails to set a performance standard for entrainment of wildlife.

Worse yet, the EPA left decisions about modernizing existing power plants to already overstrained state permitting agencies. These are the same state permitting agencies that have been authorized to order improvements for more than 30 years but have instead done almost nothing to reduce the impact power plants have on aquatic ecosystems. Today, almost half of the water permits for existing coal-fired power plants are expired because state agencies have either abandoned their obligation to faithfully uphold and enforce our clean water protections or are too overburdened to comply.

Almost 40 years after Congress identified cooling water intake as a threat to our waterways, the EPA has failed to force the owners of existing power plants—the nation's largest water users—to reduce their destructive impact. With its recent proposed rule, the EPA perpetuates this missed opportunity by leaving decisions about technology improvements to overburdened states that have proven incapable or unwilling to require power plants to phase out once-through cooling.

A clear, consistent national policy that restores and protects our waterways by phasing out once-through cooling is long overdue. The simple and cost-effective step of phasing out this outdated and destructive technology would represent a huge step forward in the nation's unfinished business of ensuring clean, safe and abundant waterways for all Americans.

APPENDIX

POWER PLANTS USING ONCE-THROUGH COOLING

TABLE 1: GREAT LAKES FACILITIES

PLANT NAME	STATE	FUEL TYPE	DAILY INTAKE CAPACITY (millions of gallons)
LAKE ERIE			
Ashtabula	Ohio	Coal	1,017
Avon Lake	Ohio	Coal	1,608
Bay Shore	Ohio	Coal	742
Conners Creek	Michigan	Coal	323
Dunkirk	New York	Coal	579
Eastlake	Ohio	Coal	1,158
J. R. Whiting	Michigan	Coal	308
Lake Shore	Ohio	Coal	623
Mistersky	Michigan	Oil/Gas	198
Monroe	Michigan	Coal	2,013
River Rouge	Michigan	Coal	648
Total Lake Erie facilities (12)			**9,217**
LAKE MICHIGAN			
B. C. Cobb	Michigan	Coal	558
Bailly	Indiana	Coal	443
Crawford	Illinois	Coal	552
Dean H. Mitchell	Indiana	Coal	746
Donald C. Cook	Michigan	Nuclear	2,143
Edgewater	Wisconsin	Coal	407
Fisk	Illinois	Coal	302
J. H. Campbell	Michigan	Coal	886
Kewaunee Nuclear	Wisconsin	Nuclear	460
Michigan City	Indiana	Coal	230
Point Beach Nuclear	Wisconsin	Nuclear	1,025
Port Washington	Wisconsin	Gas	594
Pulliam	Wisconsin	Coal	565
South Oak Creek	Wisconsin	Coal	1,137
State Line	Indiana	Coal	606
Trenton Channel	Michigan	Coal	516
Valley	Wisconsin	Coal	162
Waukegan	Illinois	Coal	852
Will County	Illinois	Coal	1,292
Total Lake Michigan facilities (18)			**13,476**
LAKE HURON			
Belle River	Michigan	Coal	950
Dan E. Karn	Michigan	Coal	465
Harbor Beach	Michigan	Coal	129
J. C. Weadock	Michigan	Coal	345
Marysville	Michigan	Coal	609
St. Clair	Michigan	Coal	1,344
Total Lake Huron facilities (6)			**3,842**
LAKE ONTARIO			
Ginna	New York	Nuclear	490
Huntley	New York	Coal	846
James A. Fitzpatrick	New York	Nuclear	596
Nine Mile Point	New York	Nuclear	490
Oswego Harbor Power	New York	Oil/Gas	1,399
Total Lake Ontario facilities (5)			**3,821**
LAKE SUPERIOR			
Presque Isle	Michigan	Coal	415
Total Great Lakes facilities (42)			**30,771**

Sources: U.S. Energy Information Administration, Form EIA-860, Annual Electric Generator Report, 2009; New York State Department of Environmental Conservation, Best Technology Available (BTA) for Cooling Water Intake Structures, draft policy, March 4, 2010, App. A, Table 1; Environmental Directory of U.S. Power Plants, Edison Electric Institute, 1991.
Note: Includes plants located on the shore of a Great Lake or on a tributary in close proximity.

TABLE 2: GULF OF MEXICO FACILITIES

PLANT NAME	STATE	FUEL TYPE	DAILY INTAKE CAPACITY (millions of gallons)
A. B. Paterson	Louisiana	Oil/Gas	216
Anclote	Florida	Oil/Gas	2,864
Barney M. Davis	Texas	Oil/Gas	337
Big Bend	Florida	Coal	1,395
Crystal River, Units 1, 2 & 3	Florida	Coal/Nuclear	2,168
Deepwater	Texas	Oil/Gas	125
Jack Watson	Mississippi	Coal	125
Fort Myers	Florida	Oil/Gas	563
Lansing Smith	Florida	Coal	274
Michoud	Louisiana	Oil/Gas	748
Nueces Bay	Texas	Oil/Gas	528
P. H. Robinson	Texas	Oil/Gas	1,715
P. L. Bartow	Florida	Oil/Gas	561
S. O. Purdom	Florida	Oil/Gas	62
Sabine	Texas	Oil/Gas	443
Sam Bertron	Texas	Oil/Gas	736
Webster	Texas	Oil/Gas	115
Total Gulf of Mexico facilities (17)			**12,975**

Source: U.S. Energy Information Administration, Form EIA-860, Annual Electric Generator Report, 2009.
Note: Includes plants located on the Gulf of Mexico or in coastal bays or other marine waters in immediate proximity.

TABLE 3: MISSISSIPPI RIVER FACILITIES

PLANT NAME	STATE	FUEL TYPE	DAILY INTAKE CAPACITY (millions of gallons)
Allen Steam Plant	Tennessee	Coal	497
Alma	Wisconsin	Coal	182
Baxter Wilson	Mississippi	Oil/Gas	592
Big Cajun 2	Louisiana	Coal	362
Burlington	Iowa	Oil/Gas	116
Genoa	Wisconsin	Coal	244
High Bridge	Minnesota	Gas	202
John P. Madgett	Wisconsin	Coal	322
Lansing	Iowa	Coal	331
LaO Energy Systems	Louisiana	Gas	131
Little Gypsy	Louisiana	Oil/Gas	934
Meramec	Missouri	Coal	675
Milton L. Kapp	Iowa	Coal	175
Monticello	Minnesota	Nuclear	367
Muscatine, Unit 1	Iowa	Coal	301
Nelson Dewey	Wisconsin	Coal	144
New Madrid	Missouri	Coal	956
Nine Mile Point	Louisiana	Coal	1,497
Prairie Island	Minnesota	Nuclear	911
Quad Cities	Illinois	Nuclear	1,353
Riverside	Iowa	Coal	247
Riverside	Minnesota	Coal	277
Robert E. Ritchie	Arkansas	Oil	443
Rush Island	Missouri	Coal	863
Sioux	Missouri	Coal	705
Waterford, Units 1,2 & 3	Louisiana	Oil/Gas/Nuclear	2,021
Willow Glen	Louisiana	Gas	1,292
Wood River	Illinois	Coal	589
Total Mississippi River facilities (28)			**16,428**

Sources: U.S. Energy Information Administration, Form EIA-860, Annual Electric Generator Report, 2009; Environmental Directory of U.S. Power Plants, Edison Electric Institute, 1991.
Note: Includes plants located on the main stem of the Mississippi. Where there is more than one cooling system at a plant site, the table gives the intake capacity for the units using once-through cooling. The Monticello nuclear plant uses mechanical draft cooling towers from May through September.

TABLE 4: HUDSON RIVER, LONG ISLAND SOUND, AND NEW YORK HARBOR FACILITIES

PLANT NAME	STATE	FUEL TYPE	DAILY INTAKE CAPACITY (millions of gallons)
HUDSON RIVER			
Bowline	New York	Oil/Gas	912
Danskammer	New York	Coal	457
Indian Point	New York	Nuclear	2,500
Roseton	New York	Oil	926
Total Hudson River facilities (4)			**4,795**
LONG ISLAND SOUND			
Bridgeport Harbor	Connecticut	Coal/Oil	541
Devon	Connecticut	Oil	262
Glenwood	New York	Oil/Gas	179
Millstone	Connecticut	Nuclear	2,190
New Haven Harbor	Connecticut	Oil/Gas	404
Northport	New York	Oil/Gas	939
Norwalk Harbor	Connecticut	Oil	298
Port Jefferson	New York	Oil/Gas	399
Total Long Island Sound facilities (8)			**5,212**
NEW YORK HARBOR			
Arthur Kill	New York	Oil	713
Astoria Generating	New York	Oil/Gas	1,254
Brooklyn Navy Yard	New York	Gas	55
East River Generating	New York	Oil/Gas	369
Ravenswood	New York	Oil/Gas	1,391
Total New York Harbor facilities (5)			**3,782**
Total River, Sound & Harbor facilities (19)			**13,789**

Sources: New York State Department of Environmental Conservation, Best Technology Available (BTA) for Cooling Water Intake Structures, draft policy, March 4, 2010, App. A, Table 1; U.S. Energy Information Administration, Form EIA-860, Annual Electric Generator Report, 2009; Environmental Directory of U.S. Power Plants, Edison Electric Institute, 1991; Dominion Nuclear Connecticut Millstone Power Station, NPDES permit, Revised Fact Sheet, December 10, 2007. http://www.ct.gov/dep/lib/dep/public_notice_attachments/draft_permits/071210_millstone_revised_fact_sheet.pdf (last visited May 11, 2011)
Note: Includes plants on the tidal estuary portion of the Hudson River, the shoreline of the Long Island Sound or on saline or brackish waters in immediate proximity to the Sound, and on the East River and Arthur Kill.

TABLE 5: CALIFORNIA COAST FACILITIES

PLANT NAME	FUEL TYPE	DAILY INTAKE CAPACITY (millions of gallons)
Alamitos	Oil/Gas	1,273
Contra Costa Units 6 & 7	Oil/Gas	440
Diablo Canyon	Nuclear	2,528
El Segundo	Oil/Gas	399
Encina	Oil/Gas	857
Harbor	Gas	108
Haynes	Oil/Gas	968
Huntington Beach	Oil/Gas	514
Mandalay	Oil/Gas	253
Morro Bay	Oil/Gas	668
Moss Landing Units 1, 2, 6 & 7	Oil/Gas	1,226
Ormond Beach	Oil/Gas	685
Pittsburg Units 5, 6 &7	Oil/Gas	462
Redondo Beach Units 5, 6, 7 & 8	Oil/Gas	892
San Onofre Units 2 & 3	Nuclear	2,438
Scattergood	Oil/Gas	495
South Bay	Oil/Gas	601
Total California facilities (17)		**15,038**

Source: Water Quality Control Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling, Final Substitute Environmental Document, State Water Resources Control Board, California Environmental Protection Agency, May 4, 2010, pp. 36–38, Section 2.4, Table 4. http://www.swrcb.ca.gov/water_issues/programs/ocean/cwa316/docs/cwa316may2010/sed_final.pdf
Note: The following plants were not included because they are retiring or repowering with dry cooling:. Hunters Point plant (retiring); South Bay plant (retiring); Humboldt Bay (repowering).

TABLE 6: CHESAPEAKE BAY FACILITIES

PLANT NAME	STATE	FUEL TYPE	DAILY INTAKE CAPACITY (millions of gallons)
Calvert Cliffs	Maryland	Nuclear	2,233
Chalk Point	Maryland	Oil/Gas	731
Chesapeake	Virginia	Coal	514
Chesterfield	Virginia	Coal	846
Gould Street	Maryland	Oil/Gas	99
Herbert A. Wagner	Maryland	Oil/Gas	1,098
Morgantown	Maryland	Coal	1,442
Possum Point	Virginia	Oil/Gas	224
Potomac River	Virginia	Coal	450
Riverside	Maryland	Oil/Gas	54
Sparrows Point	Maryland	Gas	297
Surry	Virginia	Nuclear	1,550
Yorktown	Virginia	Oil/Gas	1,445
Total Chesapeake Bay facilities (13)			**10,983**

Sources: U.S. Energy Information Administration, Form EIA-860, Annual Electric Generator Report, 2009; Environmental Directory of U.S. Power Plants, Edison Electric Institute, 1991.
Note: Includes plants located on Chesapeake Bay or on other saline or brackish waters in immediate proximity to the bay.

ENDNOTES

INTRODUCTION

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3 Ibid.

4 U.S. EPA, Final Regulations to Establish Requirements for Cooling Water Intake Structures at Phase II Existing Facilities, 69 Fed. Reg. 41,576, 41,586 (July 9, 2004)

5 California Environmental Protection Agency, Draft Final Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling, State Water Resources Control Board, May 4, 2010, http://www.waterboards.ca.gov/board_info/minutes/2010/may/050410_5_staffpresentation.pdf (last visited May 2011).

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